CLAIMS

1. A battery apparatus comprising:

an anode layer, a cathode layer, and an electrolyte operatively positioned therebetween;

a housing comprising electrically insulative material enveloping and sealed around the anode layer, the cathode layer and the electrolyte;

an anode terminal electrically connected with the anode layer and a cathode terminal electrically connected with the cathode layer, the anode terminal and the cathode terminal being electrically accessible externally of the housing; and

at least one of the anode terminal and the cathode terminal having an electrically conductive extension extending through and contacting the electrically insulative housing material, the extension having a rough surface in contact with the electrically insulative housing material, the rough surface being shaped such that a complete seal around the electrically conductive extension may be provided between the rough surface of the electrically conductive extension and the insulative housing material; and

a bond providing a complete seal continuously around the electrically conductive extension between the rough surface of the electrically conductive extension and the insulative housing material.

2. A battery apparatus according to Claim 1, wherein the electrically conductive extension is a separate component from the anode layer or the cathode layer which is adhered to the anode layer or cathode layer.

3. A battery apparatus according to Claim 1, wherein the anode layer, the cathode layer, and the electrolyte operatively positioned therebetween includes a plurality of the anode layers, the cathode layer and the electrolyte arranged to form a plurality of bicells.

4. A battery apparatus according to Claim 1, wherein both the anode terminal and the cathode terminal each have an electrically conductive extension extending through and contacting the electrically insulative housing material, each extension having a rough surface in contact with the electrically insulative housing material, each of the rough surfaces being shaped such that a complete seal continuously around each of the electrically conductive extensions may be provided between the rough surface of the electrically conductive extension and the insulative housing material, and wherein a bond provides a complete seal continuously around the electrically conductive extension between the rough surface of each of the electrically conductive extensions and the insulative housing material.

5. A battery apparatus according to Claim 4, wherein the anode layer, the cathode layer, and the electrolyte operatively positioned therebetween includes a plurality of the anode layers, the cathode layer and the electrolyte arranged to form a plurality of bicells.

6. A battery apparatus according to Claim 1, wherein the rough surface includes a plurality of surface nodules which contact and bond with the enveloping electrically insulative housing material, (i) at least a majority of the surface nodules, and/or (ii) at least 25 of the surface nodules within a 50,000 micron^2 area and/or (iii) an average of all surface discernable objects along any 500 micron length of the rough surface, having a height which is at least about 5 microns and having a maximum cross dimension which is at least 20 microns.

7. A battery apparatus according to Claim 6, wherein the height is from about 10 microns to about 25 microns.

8. A battery apparatus according to Claim 6, wherein the height is from about 12 microns to about 20 microns.

9. A battery apparatus according to Claim 6, wherein the maximum linear cross dimension is less than about 100 microns.

10. A battery apparatus according to Claim 6, wherein the maximum linear cross dimension is from about 30 microns to about 80 microns.

11. A battery apparatus according to Claim 6, wherein the height is from about 10 microns to about 25 microns, and the maximum linear cross dimension is from about 30 microns to about 80 microns.

12. A battery apparatus comprising:

an anode layer, a cathode layer, and an electrolyte operatively positioned therebetween;

a housing comprising electrically insulative material enveloping and sealed around the anode layer, the cathode layer and the electrolyte;

an anode terminal electrically connected with the anode layer and a cathode terminal electrically connected with the cathode layer, the anode terminal and the cathode terminal being electrically accessible externally of the housing; and

at least one of the anode terminal and the cathode terminal having an electrically conductive extension extending through and contacting the electrically insulative housing material, the extension having at least one outer rough surface including a plurality of surface nodules which contact and bond with the enveloping electrically insulative housing material, (i) at least a majority of the surface nodules, and/or (ii) at least 25 of the surface nodules within a 50,000 micron^2 area and/or (iii) an average of all surface discernable objects along any 500 micron length of the rough surface, having a height which is at least about 5 microns and having a maximum cross dimension which is at least 20 microns.

13. A battery apparatus according to Claim 12, wherein the height is from about 10 microns to about 25 microns.

14. A battery apparatus according to Claim 12, wherein the height is from about 12 microns to about 20 microns.

15. A battery apparatus according to Claim 12, wherein the maximum linear cross dimension is less than about 100 microns.

16. A battery apparatus according to Claim 12, wherein the maximum linear cross dimension is from about 30 microns to about 80 microns.

17. A battery apparatus according to Claim 12, wherein the height is from about 10 microns to about 25 microns, and the maximum linear cross dimension is from about 30 microns to about 80 microns.

18. A battery apparatus according to Claim 12, wherein the anode layer, the cathode layer, and the electrolyte operatively positioned therebetween includes a plurality of the anode layers, the cathode layer and the electrolyte arranged to form a plurality of bicells.

PATENT 4858-000079

19. A method of forming a battery apparatus having an anode, a cathode and an electrolyte therebetween, the method comprising the steps of:

providing an outer surface of at least one of an anode terminal material and a cathode terminal material with a rough surface;

enveloping the anode, the cathode and the electrolyte in a housing comprising electrically insulative material;

extending at least one of the anode terminal material and the cathode terminal material through the housing such that the at least one terminal material projects therefrom; and

bonding the electrically insulative material to the rough surface by flowing the electrically insulative housing material onto the rough surface to form a complete seal between the rough surface of the terminal and the electrically insulative housing material.

20. A method according to Claim 19, wherein the step of bonding to form a complete seal includes providing the complete seal continuously around the electrically conductive extension between the rough surface of the terminal and the electrically insulative housing material.

21. A method according to Claim 19, wherein the step of bonding by flowing includes melting by at least one of the steps selected from the group consisting of heat welding, ultrasonic welding and chemical welding.

22. A method according to Claim 20, wherein the step of bonding by flowing includes melting by at least one of the steps selected from the group consisting of heat welding, ultrasonic welding and chemical welding.

23. A method according to Claim 19, wherein the step of providing at least one of the anode terminal material and a cathode terminal material with a rough surface adhering the at least one of the anode terminal material and the cathode terminal material with a rough surface to another component of the anode or the cathode.

24. A method according to Claim 20, wherein the step of providing at least one of the anode terminal material and a cathode terminal material with a rough surface adhering the at least one of the anode terminal material and the cathode terminal material with a rough surface to another component of the anode or the cathode.

25. A method according to Claim 19, wherein the step of providing an outer surface with a rough surface includes at least one of the steps selected from the group consisting of brushing of the outer surface, chemical etching of the outer surface, abrading with an abrasive, and depositing a material on the outer surface.

26. A method according to Claim 19, wherein the step of providing an outer surface with a rough surface includes at least one of the steps selected from the group consisting of rotary brushing of the outer surface, electrochemical etching of the outer surface, and electrodepositing a material on the outer surface.

27. A method according to Claim 19, wherein the step of providing an outer surface with a rough surface includes providing a plurality of surface modules, (i) at least a majority of the surface modules; and/or (ii) at least 25 of the surface modules within a 50,000 micron^2 area; and/or (iii) an average of all surface discernable objects along any 500 micron length of rough surface; with a height which is at least about 5 microns and with a maximum cross dimension which is at least 20 microns.

28. A method of forming a battery apparatus having an anode layer, a cathode layer, and an electrolyte operatively positioned therebetween, the method comprising the steps of:

enveloping the anode layer, the cathode layer and the electrolyte in a housing comprising electrically insulative material;

extending an anode terminal electrically connected with the anode layer and a cathode terminal electrically connected with the cathode layer through the housing such that at least one terminal material projects therefrom;

providing an outer surface of at least one of the anode terminal and the cathode terminal with a plurality of surface nodules such that, (i) at least a majority of the surface nodules, and/or (ii) at least 25 of the surface nodules within a 50,000 micron^2 area and/or (iii) an average of all surface discernable objects along any 500 micron length of the rough surface, have a height which is at least about 5 microns and have a maximum cross dimension which is at least 20 microns; and

bonding the electrically insulative material to the rough surface.

29. The method according to Claim 28, wherein the surface nodules are provided such that the height is from about 10 microns to about 25 microns.

30. The method according to Claim 28, wherein the surface nodules are provided such that the height is from about 12 microns to about 20 microns.

31. The method according to Claim 28, wherein the surface nodules are provided such that the maximum linear cross dimension is less than about 100 microns.

32. The method according to Claim 28, wherein the surface nodules are provided such that the maximum linear cross dimension is from about 30 microns to about 80 microns.

33. The method according to Claim 28, wherein the surface nodules are provided such that the height is from about 10 microns to about 25 microns, and the maximum linear cross dimension is from about 30 microns to about 80 microns.

34. A method according to Claim 28, wherein the step of providing an outer surface with a rough surface includes at least one of the steps selected from the group consisting of brushing of the outer surface, chemical etching of the outer surface, abrading with an abrasive and depositing a material on the outer surface.

35. A method according to Claim 28, wherein the step of providing an outer surface with a rough surface includes at least one of the steps selected from the group consisting of rotary brushing of the outer surface, electrochemical etching of the outer surface, and electrodepositing a material on the outer surface.

36. A method according to Claim 19, wherein the step of bonding includes providing a complete seal continuously around the electrically conductive extension between the rough surface of the terminal and the electrically insulative housing material.